# $CO_2$ EXTRACTION – A PRODUCTION PROCESS FOR THE RECOVERY OF API

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## ABSTRACT

The desired valuable ingredients determine the required solvent. After some thermodynamic consideration about supercritical fluids and the advantages of liquid and supercritical carbon dioxide for extraction purposes some exceptional examples for the recovery of active pharmaceutical ingredients of medicinal plants are discussed.

*Keywords: $CO_2$ extraction, active pharmaceutical ingredients, medicinal and aromatic plants*

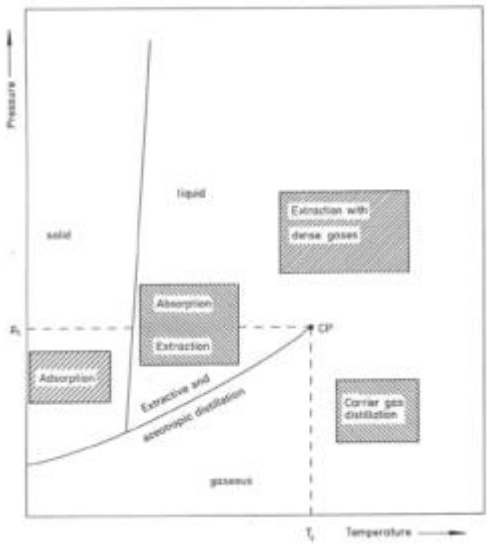
## INTRODUCTION

Plant extracts are used in many fields of human life. The use as API in natural remedies, in functional foods or nutraceuticals or in natural cosmetics asks for 100% natural extracts. The versatile $CO_2$-extraction technology can help to satisfy the demands for tailor-made highly concentrated pure extracts. $CO_2$ extracts, with their unique spectrum of ingredients composed of non-polar secondary plant metabolites, offer new possibilities especially where quality and added value are important.

## EXTRACTION SOLVENTS AND THEIR PROPERTIES

The production of plant extracts requires solvents. European legislation regulates the use of extraction solvents. Only a small number of solvents is allowed. For certified organic products only the solvents water, ethanol and carbon dioxide can be used. For the extraction of plant material the desired valuable ingredients determine the required solvent. For the recovery of pure lipophilic and less polar components $CO_2$ extraction is an established process. If the extraction of more polar components like steroids, phenolic compounds or phospholipids is desired then it is of advantage to mix some percent of ethanol into the carbon dioxide.

**Fig 1:** Thermodynamic state of an auxiliary material in separation procedures [Stahl 1986]



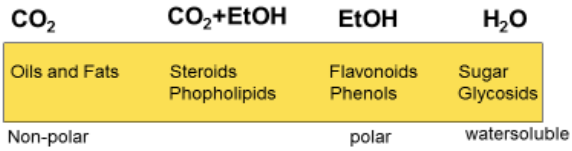

The $CO_2$ extraction method generates many positive properties. The selectivity of the solvent is adjustable by pressure and temperature in the extraction step. $CO_2$ works under gentle process conditions, sensitive ingredients can be recovered without thermal stress or oxidative degradation. Supercritical $CO_2$ has very good mass transfer properties, with a viscosity and a diffusion coefficient like a gas it has a density like a liquid. As a consequence high $CO_2$ flow rates allow short extraction times and this results in a favourable impact to the process costs. The frequently reported disadvantage of supercritical $CO_2$ extraction, the cost of the process,



https://doi.org/10.24355/dbbs.084-202001221114-0

needs to be put into context. The quality of the $CO_2$ extracts is unachievable with other extraction methods and the $CO_2$ extracts are usually part of new products.

**Table 1:** Solvent selection.




## EXCEPTIONAL EXAMPLES

After a survey of the use of $CO_2$ extracts from botanicals in products of the daily life some exceptional examples are discussed. Flowers of the well known medicinal plants camomile, calendula or arnica are source material for the $CO_2$ extraction of products for natural remedies. $CO_2$ extracts of the roots of echinacea varieties are useful ingredients for medicinal skin care and boosting the immune system. A lot of medicinal and aromatic plants are extracted with supercritical $CO_2$ and these extracts are filled in capsules for convenient dietary supplements. Guggul $CO_2$ extract, from the gum of *Commiphora mukul* tree, is prepared with a supercritical $CO_2$ – cosolvent extraction with ethanol and recovers the active constituents that show tremendous promise for human well-being. The $CO_2$ extraction of some of these examples is described in more detail.

**Table 2:** examples of the use of medicinal plant extracts

| MAP | Plant part | Active ingredients |
|---|---|---|
| Calendula | Flower | Faradiolesters |
| Arnica | Flower | Sesquiterpen-lactones |
| Oregano | Leaf | Carvacrol, thymol |
| Petasites | Herb, roots | Petasines |
| Echinacea | Roots | Alkylamides |
| Seabuckthorn | Berries | Omega fatty acids |
| Millet | Seeds | Phytosterol miliacin |

## CONCLUSIONS

Supercritical $CO_2$-extraction is a state of the art technology to recover highly concentrated pure extracts. $CO_2$ extracts can be used as API in pharmaceuticals but they have to be licensed. In Europe $CO_2$-extraction is meanwhile a standard method to produce extracts for food supplements or cosmetic ingredients, but only a few plants have the permission for pharmaceuticals because of the need for GMP processing.

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https://doi.org/10.24355/dbbs.084-202001221114-0